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Estimating the Effect of Home Court Advantage on Wins in the NBA

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Abstract
How much of a factor does home court advantage have in producing wins? This paper seeks to answer that question by using a logit regression to analyze the determinants of winning at home. The dependent variable will be a dummy variable of wins. Based on theory, it is hypothesized that home court advantage exists, and that it can be explained mostly by fan attendance, familiarity with the court, and referee bias.

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I. Introduction

During the 2012-13 National Basketball Association (NBA) season, the Houston Rockets compiled a record of 45-37 and were the eighth seed out of eight in the Western Conference playoffs.

The Rockets had a road record of just 16-25, but they went 29-12 at home. The Utah Jazz won 30 games at home last year, but only won 13 on the road. Cooper (2013), a freelance writer of the Atlanta Hawks found that in the 2013 playoffs, "Through the first 20 games of the First Round (heading into games of Friday, April 26), the home team had won 17 times." How can this major difference between records be explained? Home court advantage is the answer. Home court advantage is any type of extra benefit a team receives from playing in their home stadium. Carron et al., (2005) define home court advantage as, "the consistent finding that home teams in sport competitions win over 50% of the games played under a balanced home and away schedule." Each NBA team plays 41 games at home and 41 games on the road each year. Each team also plays each team at least once at home and once on the road. Based on Carron's definition of home court advantage, each team is expected to win at least 21 games at home each year. This home court advantage comes from fan support, familiarity with the court, and referee bias among other reasons. These factors are easily quantifiable with statistics such as game attendance, field goal percentage, and fouls called.

Home court advantage can also be measured because every court in the NBA is the same size. Every sideline is 94 feet and every baseline is 50 feet. Every basket is ten feet tall, and every rim has a diameter of 18 inches. A prime example of this is found in the popular sports movie, Hoosiers. Coach Norman Dale, played by Gene Hackman, gives a speech before the team's big game at Butler University's Hinkle Fieldhouse, a much larger arena than their home gym. Coach Dale had his team measure the length from the baseline to the free throw line and the height of the basket. The team quickly learns that the dimensions are the same as their home court. Weather is not a factor for NBA games since every game is played inside an arena. This leaves those other factors, most importantly, fan interaction and support, to explain the advantage of playing on the home court.

But how much of a factor does home court advantage have in producing wins? This paper seeks to answer that question by using a logit regression to analyze the determinants of winning at home. The dependent variable will be a dummy variable of wins. Based on theory, it is hypothesized that home court advantage exists, and that it can be explained mostly by fan attendance, familiarity with the court, and referee bias.

Section II examines previous literature on the subject of the home advantage. Section III lays out the theoretical framework, while Section IV defines the empirical model. Section V gives descriptive statistics and Section VI reports the results. Finally, Section VII offers concluding

thoughts.

II. Literature Review

The home advantage is a well-established concept in literature. There is no debate on whether or not it exists, but rather much of the literature examines either the effects of home court advantage or causes of home court advantage. For instance, much literature is devoted to the effect home advantage in sports has on betting schemes and ticket pricing (Ashman et al., 2010; Boyd and Boyd 2001; Gandar et al., 2001; Vergin and Sosik, 1999). There is literature, though, that states there may be a home disadvantage in some cases. For example, Quinn et al. (2003) study the effects of a new venue or stadium on win percentage. They find that a home advantage does not occur right away. There needs to be time to adjust to the new building. Also, when playing games at home on consecutive nights the home team plays poorly in the second game when the visitor has one to two days rest (Ashman et al., 2010). But, Nutting (2010), finds that game frequency itself has a negative impact on wins, so the home factor does not matter as much as the frequency.

Schwartz and Barsky (1977) compare home advantages between baseball, football, hockey, and college basketball. They find that the home advantage is greatest in indoor sports and primarily has to do with support of the home crowd rather than any other factor. The literature dealing with crowd factors and attendance is numerous (Forrest et al., 2005; Greer 1983; Nevill 1999; Nevill et al., 1996; Smith 2005). All of these studies report that fan attendance has a positive effect on wins. Nevill et al, (1996) specifically cites that absolute crowd size was positively related to home advantage. Salminen (1993) is the only study that finds that fan audiences cheering for the home team is not related to greater home team successes.

By studying college basketball teams, Harville and Smith (1994) find that the advantage of playing at home (in relation to playing on a neutral court) is estimated to be 4.68 ± 0.28 points. Continuing with performance based home court advantage, Cao et al., (2011) find that being the home team has a positive effect on free throw performance. The authors state that this is because the home fans may be able to distract shooters from the away team.

Carron et al. (2005) designs a conceptual framework for analyzing the home court advantage in sports. All of the variables in the model presented in this paper have come from the factors introduced in their article. They present variables ranging from game location factors, critical psychological states, critical behavioral states, and performance outcomes. For the sake of time, only a few key variables have been selected to be in the model. These variables are crowd factors, officials' behavior, and performance measures.

An interesting concept in the home court advantage is the idea of referee bias. For example, do referees call less fouls on the home team, and are they influenced to make calls based on the home crowd's reaction? Carron et al. (2005) includes this in forming their conceptual framework. Page and Page (2010) study the roles of referees in determining home field advantage in European soccer. They find that there is a significant impact of the referee in the home field advantage effect. This means that some referees cave under the pressure of a large and boisterous crowd, giving the home team more of an advantage with certain calls. Moskowitz and Wertheim (2011) also find this referee bias to be true. They study all five major professional sports (basketball, baseball, football, hockey, soccer) and agree that the home field advantage in virtually all sports is largely due to the bias of officials toward the home team.

III. Theory

Stefan Kesenne (2007) states that professional sport teams can either be profit maximizing or win maximizing. If teams are win maximizing, then they will do everything

they can to produce more wins and create an advantage over their opponents. One way teams can get this advantage is through creating a larger home court advantage. A home court advantage produces wins, and thus a higher home court advantage produces more wins. Ultimately, a production function is being proposed.

But then the question to be raised is why do teams play better at home? One explanation could be rationalized through the fans. Katie Stankiewicz (2009) wrote an article about shirking in Major League Baseball. Shirking is when a player purposefully does not perform to the best of his ability. Stankiewicz does not find any evidence that players in the MLB shirk. She reasons this to be true because of a variety of reasons; one in particular that relates to the study of home court advantage. Stankiewicz explains lack of player shirking through fan monitoring. Players are less likely to shirk in front of their home fans because they do not want to lose their approval. Fans express their approval or disapproval by not attending games, cheering or booing at games, or buying the player's jersey. Attendance and merchandise sales are a large part of a player's salary, so a player is going to make sure he performs especially well at home to keep the fans happy and his salary high. Thus, being at home should have a greater chance at producing a win over playing on the road.

Referee biases can be explained through psychological theory that people want to be liked and to be confirmed in their judgments. Referees do not like to be booed, and therefore will base some of their decisions on crowd reaction. If the home crowd is loud and boisterous, the referee is more likely to not call a foul or infraction on the home team. But, in the same situation, the referee is more likely to call a foul on the away team and receive cheers from the home crowd.

IV. Empirical Model

To get data for the models, box score data of home games for three seasons from 2008-2011 for four professional basketball teams (Utah Jazz, Houston Rockets, Atlanta Hawks, Chicago Bulls) is examined. This results in a total sample size of 123 game entries per team. Performance based data statistics such as field goal percentage, free throw percentage, fouls, and points allowed were retrieved from basketball-reference.com (Kubatko, J., 2013). The attendance data was obtained from nba.com (NBA Stats, 2013). Using data from the selected time period allows for a recent analysis while avoiding lockout years in the NBA. These four teams were selected based on their win/loss records. There are two teams from each conference, and no teams are in the same division. The Jazz and the Bulls were selected because they have stellar home records but a poor win percentage on the road. The Rockets and the Hawks were chosen because they also have good records at home, but they have better records on the road than the Jazz and Bulls. Those teams have around a .500 record on the road. Thus there is a slight selection bias when examining these teams. Each team has two models, a base model with attendance and the away win percentage and a more complex model with those two variables plus other performance-based variables. This results in eight total models. It is important to note that all of these variables consist of data from only home games.

The first model contains two independent variables, the log of the attendance and the teams' away win percentage. This is the base model to see solely the effect of attendance on the dependent variable of wins. This dependent variable is a dummy variable measuring wins, a win as 1 and a loss as 0. As such, a logit model will be used. The logit model enables a more accurate analysis over an ordinary least squares (OLS) regression because the dependent variable is either a 0 or a 1. Problems occur when using OLS with a dependent dummy variable because the estimated probability of a win can turn out to be less than 0 or greater than 1 (which is not possible for probabilities). This could result with an inaccurate best-fit line. A logit model avoids this problem by limiting estimated probabilities to be between 0 and 1. Logit also

fixes the heteroscedasticity problem of OLS regression with a dependent dummy. The second model has the same dependent variable, but adds more independent variables. Table 1, in the appendix, describes each variable and shows its expected sign. In addition to the attendance variable, statistically based performance variables measuring field goal percentage, free throw percentage, foul ratio, and points given up, all at home, are entered into the model. The ratio of fouls called on the away team over the fouls called on the home team is the final independent variable. This variable will measure if there is a referee bias that leads to a home court advantage. Finally, a variable controlling for the quality of each team is incorporated in the model. This is a variable that measures the team's away winning percentage. All variables are expected to have a positive effect on producing a win except the Points Allowed variable. The Points Allowed variable is expected to be negative because as this variable increases, the chance of winning decreases. Finally, an error term is included at the end of the model. The models are as follows:

$$\ln(Win) = \beta 1 + \beta 2(Log\_Attendance) + \beta 3(Away\_Win\_Percentage) + \mu$$

$$\ln(Win) = \beta 1 + \beta 2(Log\_Attendance) + \beta 3(FG\_Percentage) + \beta 4(FT\_Percentage) + \beta 5(Foul\_Ratio) + \beta 6(Points\_Allowed) + \beta 7(Away\_Win\_Percentage) + \mu$$

V. Descriptive Statistics

Table 2, in the appendix, lists descriptive statistics showing differences in performance between games played at home and games played on the road. Statistics include the team's home and away record, home and away field goal percentage, and the plus/minus statistic of average points scored at home and on the road. Every year, each team has a better home record than away record. Each team has a higher home field goal percentage than away field goal percentage except the 2010-11 Houston Rockets. But this only a 0.7 percent difference. The home and away plus or minus statistic is a great indicator of home court advantage. A positive number indicates more points scored than points given up, while a negative number signifies more points given up than scored. For example, the 2008-09 Atlanta Hawks, on average, scored 5.7 more points at home than their opponents. However, on the road, they scored 2.5 points less per game than their opponents. The home points plus/minus per game is greater than the away points plus/minus per game for every team and every year except the 2010-11 Atlanta Hawks. However, the difference between the home and away statistic is only 0.1 points.

VI. Results

Table 3, in the appendix, shows the results of all models. Beginning with the base model, Model 1, the results of whether attendance has a factor in producing a win at home is found. By controlling for only the away win percentage, it is found that the Log Attendance variable is significant for only two teams, the Atlanta Hawks and Chicago Bulls. But, the sign of the coefficient is correct only for the Chicago Bulls. The coefficient is negative for the Atlanta Hawks, Houston Rockets, and Utah Jazz, with the Hawks being the only other significant result. The negative sign is not what was expected, but can easily be explained. When good teams come into town, the home attendance increases, but the winning percentage decreases. For example, when LeBron James and the Miami Heat play a road game, fans come out in large numbers to see him play. But, his team is very good and will most likely win the game, even though they are on the road. Therefore, although attendance is high and should create a home court advantage, the probability of a win actually decreases.

Model 2 shows more encouraging results. Every performance-based variable is highly significant for each team, except the foul ratio variable for the Atlanta Hawks. This means that there is a referee bias for every team except for the Hawks. The signs for all performance-based variables are what were expected. The home field goal percentage variable has the greatest impact

on producing a win at home. The variable is significant at the 1 percent level for each team. For the Atlanta Hawks, an increase in the field goal percentage increases the probability of producing a win by 46 percent. This number, however, does seem unlikely and could be skewed due to the fact that the visiting team's field goal percentage is not accounted for. The free throw percentage variable is also significant for all teams. For the Chicago Bulls, an increase in their free throw percentage at home gives them a 9.57 percent increase in probability of winning the game. The foul ratio variable for the Houston Rockets shows that for an increase in the foul ratio, meaning that if the away team has more fouls called on them than the home team, the probability of a win increases 4.71 percent. The Points Against variable is negative for all teams, which was expected. It is negative because the more points the opponent scores, the less of a chance the home team has of winning. For the Utah Jazz, this coefficient is significant at the 1 percent level and shows that for each point scored against, the probability of a win decreases 1.8 percent. Finally, the Log Attendance variable and the Away Win Percentage variable are not significant at all for any team in Model 2. This could be because the sample size, at 123, is small. Perhaps with more games accounted for, the attendance would matter.

VII. Conclusion

Proof of a home court advantage was expected to be found through the selected variables in the model. The main variable of attendance was insignificant in all but two logit regressions. Therefore, one cannot say that home attendance has an impact on increasing the probability of a win. This contradicts with the majority of the current literature available. This only agrees with Salminen (1993), who found that the home fan audience cheering is not related to greater home team successes. Again, this could be because the sample size only consists of 123 games. However, through descriptive statistics and the performance-based variables in the model, a home court advantage is found. Fg Percentage, Ft Percentage, and Points Against are all highly significant in Model 2. This agrees with the theory that teams will not shirk at home in front of their home fans, and they will play better at home. The descriptive statistics show that teams have better records at home than they do on the road. These statistics also prove that teams shoot better percentages at home than they do on the road. This all proves a home court advantage. Finally, the Foul Ratio variable proves a home court advantage for three teams. This means that there is a referee bias towards the Bulls, Rockets, and Jazz when they play at home. A referee bias can be explained by fan influence. The referee does not want to make the home fans boo him, so his calls are more favorable toward the home team. So although the attendance variable is not significant, the fans still have an impact on the game through referee biases. Referee biases could lead teams to change the way they play. If they know there is a referee bias, home teams could be more likely to attack the basket on offense and try to draw fouls. They would take more chances on offense driving to the basket because they know that the referee is more than likely to call a foul on the opposing team. On the defensive side of the ball, teams could be more aggressive because they know that referees would be less willing to call a foul. This result agrees with both Page and Page (2010) and Moskowitz and Wertheim (2011).

Future research could include more games to increase the sample size. More teams can also be analyzed to gain more variability in the model. This could yield interesting results as it could show that there is a greater home court advantage for some teams than others. Finally, a combined model of teams could be analyzed to see the combined effect of home court advantage in the NBA.

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Appendix

Table 1: Variables List

Variable	Description	Expected Effect
Log_Attendance	The log of attendance for home games	Positive
FG_Percentage	The field goal percentage at home	Positive
FT_Percentage	The free throw percentage at home	Positive
Foul_Ratio	The ratio of fouls called on the visiting team divided by the fouls called on the home team	Positive
Points_Allowed	The number of points allowed at home	Negative
Away_Win_Percentage	Control variable of the team's win percentage on the road	Positive

Table 2: Descriptive Results

Team	Year	Home record	Away record	Home FG%	Away FG%	Home points +/-	Away points +/-
Atlanta Hawks	2008-09	31-10	16-25	47.0%	44.7%	5.7	-2.5
	2009-10	34-7	19-22	47.2%	46.4%	8.5	0.8
	2010-11	24-17	20-21	46.5%	45.9%	-0.9	-0.8
Chicago Bulls	2008-09	28-13	13-28	46.0%	45.3%	4.1	-4.7
	2009-10	24-17	17-24	45.2%	45.1	0.7	-3.9
	2010-11	36-5	26-15	46.4%	45.9	10.2	4.4
Houston Rockets	2008-09	33-8	20-21	45.6%	45.0%	8.8	-0.8
	2009-10	23-18	19-22	45.6%	43.8%	1.5	-2.3
	2010-11	25-16	18-23	45.1%	45.8%	4.7	-0.3
Utah Jazz	2008-09	33-8	15-26	48.6%	46.3%	9.5	-4.2
	2009-10	32-9	21-20	51.1%	47.1%	9.5	1.2
	2010-11	21-20	18-23	41.1%	45.9%	0.8	-4.5

Table 3: Analysis Results

Model	Variables	Atlanta Hawks	Chicago Bulls	Houston Rockets	Utah Jazz
Model 1	Log_Attendance	7.33**	19.7**	-5.48	-17.3
	Away_Win_Percentage	-9.30	3.11*	22.2**	6.95
	Pseudo R^2	0.046	0.071	0.007	0.029
	Sample Size	123	123	123	123
Model 2	Log_Attendance	-2.49	7.68	-7.19	13.6
	Fg_Percentage	46.0***	42.2***	45.3***	41.7***
	Ft_Percentage	14.5***	9.57**	7.65**	7.28**
	Foul_Ratio	1.09	3.21**	4.71***	5.01***
	Points_Against	-0.23***	-0.18**	-0.16***	-0.18***
	Away_Win_Percentage	-7.95	3.38	-4.68	-2.09
	Pseudo R^2	0.557	0.528	0.452	0.542
	Sample size	123	123	123	123

***Significant at the 1% level
**Significant at the 5% level
*Significant at the 10% level